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A Soviet technical manual entitled Low Power Junction Transistor Tester Type L 2-2 - Instruction Manual and Certificate [redacted] The manual is in English and consists of 30 pages and three diagrams.

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LOW POWER JUNCTION TRANSISTOR TESTER

TYPE Л12-2

Instruction Manual and Certificate

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LOW POWER JUNCTION TRANSISTOR TESTER

Type J12-2 (WHHT-I)

Instruction Manual and Certificate

- 1963 -

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I. DESCRIPTION

A. General

The Instrument is designed for measurement of basic parameters of low power junction transistors both N-P-N and P-N-P types. The Instrument may operate in ambient temperature range of +10°C to +35°C with 80 per cent of relative humidity.

B. Operating Specifications

1. The instrument can measure the following parameters of the grounded-base circuit using a 270 cps ± 10 per cent test signal:

a. h_{11} - from 3 to 300 ohms with ± 5 per cent accuracy of full scale.

b. h_{12} - from $3 \cdot 10^{-3}$ to $3 \cdot 10^{-5}$ with ± 5 per cent accuracy of full scale.

c. h_{22} - from $3 \cdot 10^{-6}$ to $3 \cdot 10^{-8}$ with ± 5 per cent accuracy of full scale.

d. α - from 0.7 to 1.0 with ± 5 per cent accuracy of full scale.

e. I_c - from 0.1 to 5 milliamperes ± 5 per cent accuracy

f. I_{co} - from 2 to 50 microamperes, ± 5 per cent accuracy.

In order to measure currents less than 2 microamperes the terminals for connection an external meter are provided.

2. The instrument can measure the following parameters of the grounded-emitter circuit using a 270 cps ± 10 per cent test signal:

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a. h_{11} - from 100 to 10,000 ohms, with ± 10 per cent accuracy of full scale.

b. h_{12} - from $3 \cdot 10^{-3}$ to $3 \cdot 10^{-5}$, with ± 10 per cent accuracy of full scale.

c. h_{12} - from $3 \cdot 10^{-4}$ to $3 \cdot 10^{-6}$, with ± 10 per cent accuracy of full scale.

d. β - from 10 to 1000, with ± 10 per cent accuracy of full scale.

e. Y_{22} - from $3 \cdot 10^{-4}$ to $3 \cdot 10^{-6}$, with ± 10 per cent accuracy of full scale.

f. I_0 - from 0.1 to 5 milliamperes, ± 5 per cent accuracy.

2. The instrument can measure the following parameters using a 465 kc/s ± 10 per cent frequency:

a. C_0 - collector-to-base capacitance from 5 to 100 pF at d-c emitter current with ± 15 per cent ± 3 pF accuracy.

b. $C_0 R_b$, i.e. a parameter which determines a feedback at h.f. The read up minimum is 100 pV ohm.

4. The instrument can measure current gain from 0.3 to 1.5 using test frequencies from 100 kc/s to 10 mc/s (from an external source).

5. Measurement ratings can be set on the following ranges:

a. I_0 - from 0.1 to 5 milliamperes, ± 5 per cent accuracy.

b. U_c - from 2 to 50 volts, ± 2.5 per cent accuracy.

6. Power: 220 volts ± 10 per cent, 50 cps, 170 watts.

7. Dimensions: 620 x 320 x 302 mm.

8. Weight: 31.8 kg.

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9. Instrument Complement:

a. Л2-2(ИПИТ-I) Tester - one

b. Technical Papers -1 file

c. Screen cable for attaching an external generator of the ГСС-6 type-one

d. Translator equivalent - two

e. Spare parts box - one

II. THEORY OF OPERATION

The Instrument type Л2-2 (ИПИТ-I) consists of the following units:

a. 270 cps generator

b. Wide band amplifier.

c. Selective preamplifier.

d. Commutation circuit.

e. Rating check circuit.

f. Power supply.

A. Circuit Function

1. Generator

The RC-generator uses the 6Н1П tube (schematic symbol - II). The left section of the triode operates as a generator and the right one is a cathode follower. By rotating the potentiometer (121) marked " частота" (frequency) it is possible to vary in a small range the frequency. By rotating the potentiometer (128) one may change the amplitude and shape of the output voltage. The filter (135,136) serves to decouple the generator from the rest of the circuitry. The shaft end of the potentiometer (132) on the front panel marked "калибровка" (Calibration) serves to adjust the generator output voltage. The voltage is of the order of 30 volts

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2. Wide Band Amplifier

It serves to measure transistor h.f. parameters. The amplifier employs tubes of the 6H2П type (16,17,18,19). Each pair has a deep negative feedback including resistors (258 and 255) in each loop. A crystal diode (262) of the D2B type is connected across the amplifier output. A M-24 panel meter (265) serves to indicate transistor parameters. Full-scale deflection current is 100 microamperes.

3. Selective Preamplifier

The circuit uses the 6H2П type tubes (13,14,15). The tube (13) operates as a preamplifier. The amplified signal taken from the tube (13) output is fed through the capacitor (200) to the selective amplifier (14). The right sections of the double triodes (14,15) operate as amplifiers and the left ones as cathode followers. Selectivity is achieved by introduction of a selective feedback. The resistors and capacitors (203,209, 206, 207, 204, 205, 208 and 219, 220, 221, 222, 223, 224, 218) represent a double T-bridge. The potentiometer "fl" (207) and potentiometer "Q" (222) are designed for 270 cps resonance tuning of the stages.

4. Commutation Circuit

Instrument commutation is made by spring type switch-keys of the KPP type. They perform the following manipulations:

K1 switches the I_0 meter ranges.

K2 switches the U_c meter ranges.

K3 P-N-P-to-N-P-N switch.

K4 switches the I_c meter ranges. When switching on 0.05 ma range the emitter circuit becomes disconnected, i.e. the meter reads I_{c0} value.

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K5 - measured parameters switch.

K6 - α -measurement switch (using h.f.)

K7 - measurement range selector switch.

K8, K9, K10, K11, K12 } keys for measured parameter readings.

K13 - mode of operation switch.

K14 - I_e-I_c switch.

The commutation circuit uses miniature relays of the РСМ-2 type. Grounded base, grounded emitter or h.f. measurement procedure is carried out by attaching a transistor to be measured into the separate panels (144,180, 188). When measuring the C_cR_b parameter the cathode follower is used. It serves to eliminate the effect of stray capacitance of the cable attached to the voltmeter. The cathode follower uses the 6Е1П type (12). The medium position of the keys corresponds to "Калибровка" (calibration). In this case the generator output is directly connected to the millivoltmeter input.

5. Rating Check Circuit.

To check the d-c ratings the following meters are present:

Milliammeter (99) which measures I_e and I_c.

Voltmeter (84) which measures U_c. It uses the 6Н2П type (9) and has a high input resistance.

6. Power Supply Unit.

The power supply comprises two rectifiers (+300 volts and -205 volts) with electronic regulation. The rectifiers supply voltages to the tester and tested transistor. To feed the col-

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lector circuit a source with low input resistance is required. This is realised from the circuit with the 6НЗП tube (8). To excite the relays a rectifier is provided which uses 111111 crystal diodes of the Д7Г type.

III. OPERATING INSTRUCTIONS

A. Instrument Switching On.

Before the instrument is switched on it is necessary to make certain that power line voltage is 220 volts ±10 per cent. Put the collector voltage setting and emitter current setting knobs to the extreme counterclockwise positions. After switching on allow the instrument to warm up for 15-20 minutes. Then by turning the calibration knob ("калибровка") set the meter pointer at the black triangle on the scale, keys for measurement parameters reading being put in the medium positions.

B. Grounded Base Parameters Measurement

1. Attach the transistor to be tested to the socket marked "общая база" (grounded base).

2. Put the mode of operation switch to the "общая база" (grounded base) position.

3. P-N-P-to-N-P-N switch should be set to the necessary position.

4. By turning the collector voltage setting and emitter current setting knobs set the meter indicators to the necessary positions that correspond to the required d-c ratings.

5. By throwing the corresponding key of parameters reading one can read the measured parameter value. In this case using

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the measurement range switch as well as measurement range table may be necessary. This table is situated on the front panel.

C. Grounded Emitter Parameters Measurement.

1. Attach the transistor to be tested to the medium socket.

2. Put the mode of operation swtich to the "общий эмиттер" (grounded emitter) position.

3. D-c ratings should be set as described above in point B4.

4. Parameter measurements are carried out in the same way as it was described for grounded base parameter measurements.

It is necessary to note that Y_{22} parameter measurement can be made at grounded emitter circuit only.

D. H.F. Parameter Measurements.

1. Attach the transistor to be tested to the right socket.

2. Put the mode of operation switch to the " измерение на в.ч. " (h.f.measurement) position.

3. D-c ratings should be set as described above in point B4.

4. Connect the pulse generator of the ГСС-6 type to the coaxial connector marked "ВХОД В.Ч."—(h.f. Input) by means of a cable to be supplied.

5. When α-measurement is required put the key marked " ОТСЧЕТ α" (α-reading) to the " α-КОНТР." (α-control) position. By turning the output voltage setting knob of the generator the indicator of the parameter meter should completely deflect. Throw the " ОТСЧЕТ α "key from the " α-КОНТР." to the " α ОТСЧЕТ" (α-reading) position. α-parameter value should be read on the parameter indicating meter. The full scale reading covers the range from zero to I.

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6. Before measuring C_c the $C_c - R_bC_c$ key should be thrown to the "$C_к$" (C_c) position. Remove the transistor out of the socket and supply the output of the ГСС-6 generator to the instrument. By turning the frequency setting dial make the parameter reading meter indicator maximum deflect. In this case the reading capacitor scale is set to zero. Attach the transistor to the socket. Then by turning the reading capacitor knob make again the parameter reading meter indicator maximum deflect. The value of the capacitance is read on the capacitance scale with ± 15 per cent, ± 3 pF accuracy.

7. Before measuring R_bC_c the $C_c - R_bC_c$ key should be put to the "$R_б C_к$" position. Remove the transistor out of the socket, and insert there the standard to be supplied. Its value is 1500 pF ohm. By changing the generator output voltage set the reading meter indicator against the half of the scale. In this case the R_bC_c full scale reading is 3000 pF ohm. If the meter indicator deflects to the end of the scale the R_bC_c full scale reading corresponds to 1500 pF ohm. Then remove the standard from the socket and insert the transistor to be tested. The C_cR_b value is read on the reading meter scale. C_cR_b measurement frequency is up to 5 mc/s. The standard circuit is shown in Fig.1.

E. I_{co} Measurements

Insert the transistor to be measured to the socket marked "общая база" (grounded base) or "общий эмиттер" (grounded emitter). Throw the mode of operation switch to the "общая база" or "общий эмиттер" position. Put I_c; $I_э$ key to the upper position. It corresponds to I_c measurement. The measurement [illegible]

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collector key should be put to the 0.05 ma (I_{oo}) position. I_{oo} value is read on the collector current meter scale.

F. Parameter Measurements at Small Emitter Currents and Low Collector Voltages

These parameters are practically measured at any d-c rating in the following range:

I_e 0.1 - 5 milliamperes

U_o 2 - 50 volts.

Sometimes however it is required to measure transistor parameters at small emitter currents and low collector voltages. The lower limit of U_o and I_e is determined by the a-c components of currents and voltages applied to the electrodes of the transistor to be tested. For normal operation of the instrument the d-c components of currents and voltages should be at least twice the value of the a-c components. Appendix I shows the a-c components applied to the transistor to be tested for each specific case.

G. Tube Replacement

The replacement of the tubes (8,11,12, 16,17,18,19) does not effect the instrument operation. After replacing the tube (9) the collector voltage meter zeroing may be changed. For zero setting put the P-N-P-to-N-P-N switch in the medium position and rotate the " Уст.0 " (zero setting) potentiometer (97). On replacing the selective amplifier tubes (13,14,15) voltmeter sensitivity may be changed. If the sensitivity is changed by a little value no readjustment is required. (In this case the keys are at the " калибровка " (calibration) position and while turning the " калибровка " knob the meter indicator stays against the black triangle on the scale). If the sensitivity is changed

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by a value that the meter indicator does not stay at the black triangle, the readjustment is necessary. For this:

1. Put the mode of operation switch to the " общая база" (grounded base) position.

2. Insert a 100 ohm ±1 per cent resistor into the socket across the emitter - base taps.

3. Throw the measurement range selector switch to the II position.

4. Put the h_{11} switch to the upper position.

5. Obtain the maximum deflection of the reading meter indicator by turning the " ФI "и ФII" knob of the potentiometer (207 and 222). After it turn the " ∞ " knob of the potentiometer (128) untill the meter indicator deflects to the 100-th division.

6. Put the h_{11} switch again to the medium position. Set the reading meter indicator at the black triangle on the scale by turning the " Ампл." (amplitude) potentiometer (174).

7. After readjustment lock these potentiometers.

IV. TROUBLESHOOTING

1. While calibration is being made the reading meter indicator does not stay at the black triangle on the scale.

Cause: a. Poor sensitivity of the " параметри " meter.

b. Ageing of amplifier tubes (13,14,15,16,17,18,19)

Remedy: a. Replace the meter

b. Replace the amplifier tubes (13,14,15,16,17, 18,19) and make readjustment (See para, Tube Replacement).

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2. No click is heard when the parameter reading keys are switched.

Cause: Fault in the relay rectifier circuit.

Remedy: a. Check the Д7Г diode

b. Check the capacitor (45)

3. When the keys are at the " КАЛИБРОВКА " positions the meter indicator does not deflect at all.

Cause: a. Generator tube (11) is faulty

b. One of the amplifier tubes is at fault (13,14, 15,16,17,18,19).

Remedy: a. Replace the faulty tube.

b. Replace the faulty tube.

4. Emitter current is not fixed.

Cause: The twin switch (61) marked "$I_э$ " is at fault.

Remedy: Replace the faulty switch (61).

5. Collector current is not fixed.

Cause: The cathode follower tube (8) is damaged.

Remedy: Replace the faulty tube.

6. When h.f. measurement is carried out the collector capacitance is not measured. (No resonating is present).

Cause: Capacitor (149) plates are short-circuited.

Remedy: Remove the short-circuit of the plates.

7. Collector current is fixed but the collector voltage meter does not read anything.

Cause: D.c. amplifier tube (9) is at fault.

Remedy: Replace the damaged tube.

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V. PERIODICAL CHECK OF INSTRUMENT

Annual check of the instrument is necessary. I_{co}, h_{11}, h_{12}, C_o, C_c R_b, and h.f. additional measurement errors are checked as follows.

1. Measurement error check at the grounded-base circuit is carried out by inserting the required resistors into the measurement socket. All resistors tolerance ± I per cent.

	Range	I	II	III
h_{11}	Base-Emitter Resistance	30 ohms	100 ohms	300 ohms
h_{12}	Base-Emitter Resistance	300 ohms	1000 ohms	3000 ohms
	Collector-Emitter Resistance	1 meg	1 meg	1 meg

2. Measurement error check at the grounded emitter citcuit is made by inserting the required resistors into the measurements socket. All resistors tolerance ± I per cent.

	Range	I	II	III
h_{11}	Base-Emitter Resistance	1000 ohms	3000 ohms	10000ohms
h_{12}	Base-Emitter Resistance	300 ohms	1000 ohms	3000 ohms
	Collector-base Resistance	1 meg	1 meg	1 meg

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3. I_{co} measurement error is checked by means of an external microammeter connected between collector and base taps of the socket at the grounded base circuit.

4. Additional frequency error check is carried out by short-circuiting emitter and collector taps of the h.f. socket ($\alpha = 1$) and reading the difference of meter indications at the "α-КЗП." and "α-ИЗМ." positions of the key respectively, frequencies being varied.

5. C_c measurement error is checked by measuring a standard capacitor connected across collector and base taps.

6. C_cR_b measurement error check is made as follows:

a. First measure the standard resistance and capacitance and then estimate their prodict. The resistance value is measured with $\pm$ 0.5 per cent error and the capacitance - with $\pm$ I per cent.

b. Measure a resistance-capacitance product. For this the capacitor should be inserted across collector and emitter taps, and the resistor is connected to the emitter and base taps.

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C E R T I F I C A T E

1. Manufacturer Certification

J2-2 (MM -1)Low Power Junction Transistor Tester No. 2345 is in full accordance with Technical Specifications T.289.0.S.TY and ready for operation.

Date of manufacture 18 gennaio 1963.

Inspector [illegible] Signature

2. Warranty

Except for the replacement of tubes and other elements not produced at our factory we assume responsibility for replacing or repairing any components free of charge if the fault has not been caused by misuse, alteration, faulty installation, or abnormal operating conditions.

3. Reclamation

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Appendix I

Variable Signal Values

Range	I		II		III	
Measured Parameters	I_e, I_b	U_c	I_e, I_b	U_c	I_e, I_b	U_c
	micro-amperes	milli-volts	micro-amperes	milli-volts	micro-amperes	milli-volts
Grounded-Base Measurements						
h_{11}	3.3	-	I	-	0.33	-
h_{12}	-	333	-	I00	-	33.3
h_{22}	-	333	-	I00	-	33.3
	3.3	-	I	-	0.33	-
Grounded-Emitter Measurements						
h_{11}	0.33	-	0.1	-	0.33	-
h_{12}	-	333	-	I00	-	33.3
h_{22}	-	333	-	I00	-	33,3
H.F. Measurements						
	50	-	50	-	50	-
C_c	50	-	50	-	50	-
$r_b C_c$	50	-	50	-	50	-

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Appendix 2

Л2-2(ИППФ-I) Tube Ratings

Schem. Symb.	Tube Type	Pin Number 1	2	3	4	5	6	7	8	9
1	5Ц4С	–	–	–	390	–	390	–	+480	–
2	6Ц4П	360	–	–	–	145V	–	360	–	–
3	6С19П	470	235	470	–	–	470	235	470	+300
4	6С19П	115	-35	115	–	–	115	-35	115	–
5	6Ж3П	-96	-96	–	–	-35	-65	–	–	–
6	СГ2П	-96	-205	–	-205	-96	–	-205	–	–
7	6Ж2П	-0.85	–	–	–	235	26	0	–	–
8	6Н1П	+300	-6.0	+0.3	fil.	–	300	-6.0	+0.3	0
9	6Н2П	300	0	+2.7	fil.	–	300	0	+2.7	0
II	6Н1П	225	0	+4.5	fil.	–	135	-75	-76	0
12	6Ж1П	0	+3.2	fil.	–	150	150	+3.2	–	–
13	6Н2П	72	-0.1	+0.35	5.4	0	130	0	+1.35	0
14	6Н2П	190	-2.55	-1.0	fil.	–	90	-1.2	0	0
15	6Н2П	190	-2.55	–	fil.	–	90	-1.2	0	0
16	6Ж1П	0	+0.8	fil.	–	80	58	–	–	–
17	6Ж1П	0	+0.8	fil.	–	80	58	–	–	–
18	6Ж1П	0	+0.8	fil.	–	80	58	–	–	–
19	6Ж1П	0	+0.8	fil.	–	80	58	–	–	–

Note: 1. All above mentioned voltages are measured with an electronic voltmeter in relation to earth.

2. P-N-P-to-N-P-N key is in "P-N-P" position.

3. The rest of keys are in the medium position. Rating knobs are in extreme counterclockwise positions.

4. All above mentioned voltages may differ by ±10 per cent from rating.

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R2 - 2 PARTS LIST

Capacitors

Schem. Symbol	Value	Tolerance per cent	Description	Quant.
1	2	3	4	5
20	10 μF	± 10	Metallic, Paper, Sealed, 600 V	1
22	10 mF	± 10	Metallic, Paper, Sealed, 600 V	1
9	0.5 μF	± 10	Metallic, Paper, Sealed, 500 V	1
28	0.5 μF	± 10	Metallic, Paper, Sealed, 500 V	1
32	0.5 μF	± 10	Metallic, Paper, Sealed 500 V	1
32	0.5 μF	± 10	Metallic, Paper, Sealed, 500 V	1
40	0.5 μF	± 10	Metallic, Paper, Sealed, 500 V	1
41	10 μF	± 10	Metallic, Paper, Sealed, 500 V	1
43	10 μF	± 10	Metallic, Paper, Sealed, 500 V	1
44	2000 μF		Electrolytic, 12 V	1
45	200 μF		Electrolytic, 50 V	1
105	2 μF	± 10	Metallic, Paper, Sealed, 300 V	1
111	2x0.1μF	± 10	Metallic, Paper, Sealed, 400 V	1
113	20 μF	± 10	Metallic, Paper, Sealed, 300 V	1
114	750 pF	± 10	Mica, 500 V	1
116	620 pF	± 10	Mica, 500 V	1
118	2200 pF	± 10	Mica, 500 V	1
120	0.01 μF	± 10	Paper, Sealed, 600 V	1
126	20 μF		Electrolytic, 400 V	1
130	2 μF	± 10	Metallic, Paper, Sealed, 300 V	1
134	0.1 μF	± 10	Paper, Sealed, 200 V	1
135	20 μF		Electrolytic, 400 V	1

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Schem. Symbol	Value	Tolerance per cent	Description	Quant.
138	0.1 µF	± 10	Paper, Sealed, 200 V	1
141	220 µF	± 10	Mica, 500 V	1
142	820 pF	± 10	Mica, 500 V	1
146	8-30 pF		Trimmer, Ceramic	1
148	750 pF	± 10	Mica, 500 V	1
149	8-130pF		Variable	1
150	0.05 µF	± 10	Paper, Sealed, 400 V	1
151	15 pF	± 10	Ceramic, Tubular, 700 V	1
155	1000 pF	± 10	Mica, 500 V	1
178	750 pF	± 10	Mica, 500 V	1
181	20 µF	± 10	Metallic, Paper, Sealed, 300 V	1
182	2000 µF		Electrolytic, 12V	1
183	2000 µF		Electrolytic, 12V	1
185	0.01 µF	± 10	Mica, 250 V	1
189	0.05 µF	± 10	Paper, Sealed, 400 V	1
196	0.05 µF	± 10	Paper, Sealed, 400 V	1
198	20 µF		Electrolytic, 400 V	1
200	0.01 µF	± 10	Paper, Sealed, 600 V	1
204	0.05 µF	± 5	Paper, Sealed, 400 V	1
205	4700 pF	± 5	Mica, 500 V	1
208	0.05 µF	± 5	Paper, Sealed, 400 V	1
212	0.01 µF	± 10	Paper, Sealdd, 600 V	1
215	20 µF		Electrolytic, 400 V	1
216	0.05 µF	± 5	Paper, Sealed, 400 V	1
220	4700 pF	± 5	Mica, 500 V	1
223	0.05 µF	± 10	Paper, Sealed, 400 V	1
229	5000 pF	± 10	Mica, 500 V	1

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Schem. Symbol	Value	Tolerance per cent	Description	Quant.
232	IO µF		Electrolytic IO V	1
234	2x0.5 µF	± IO	Metallic,Paper,Sealed, 200 V	1
235	0.01 µF	± IO	Paper , Sealed, 600 V	1
240	IO µF		Electrolytic, IO V	1
245	20 µF		Electrolytic, 400 V	1
246	0.01 µF	± IO	Paper, Sealed, 600 V	1
248	IO µF		Electrolytic, IO V	1
250	2x0.5 µF	± IO	Metallic,Paper,Sealed, 200 V	1
251	0.01 µF	± IO	Paper, Sealed, 600 V	1
257	IO µF		Electrolytic, IO V	1
261	0.1 µF	± IO	Paper,Sealed, 200 V	1
264	20 µF		Electrolytic, 400 V	1
266	500 µF		Electrolytic, 30 V	1

Resistors

Schem. Symbol	Value	Tolerance per cent	Description	Quant.
23	I meg	± IO	I Watt Composition	1
24	5.1 K	± IO	IO Watts Wire Wourd	1
26	91 K	± IO	2 Watts Composition	1
27	56 K	± IO	2 Watts Composition	1
29	9.1 K	± IO	I Watt Composition	1
30	IO K		2 Watts Patentiometer	1
31	33 K	± IO	I Watt Composition	1
33	51 K	± IO	I Watt Composition	1
34	IO K		2 Watts Potentiometer	1
35	47 K	± IO	I Watt Composition	1
36	9.1 K	± IO	I Watt Composition	1

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Schem. Symbol	Value	Tolerance per cent	Description	Quant.
37	3.9 K	± IO	I Watt Composition	1
39	I meg	± IO	I Watt Composition	1
60	IO K	± IO	2 Watts Composition	1
61	33 K		2 Watts Potentiometer	1
62	IO K	± IO	2 Watts Composition	1
63	5.1 K	± IO	I Watt Composition	1
64	5.1 K	± IO	I Watt Composition	1
65	15 K	± IO	2 Watts Composition	1
66	30 K	± IO	2 Watts Composition	1
67	6.8 K	± IO	1/2 Watt Composition	1
68	30 K	± IO	1/2 Watt Composition	1
69	200 K	± IO	1/2 Watt Composition	1
70	24 K	± IO	I Watt Composition	1
71	180 K	± IO	1/2 Watt Composition	1
72	132 ohm	± 0.5		1
73	202.5 ohm	± 0.5		1
75	1145 ohm	± 0.5		1
77	180 K	± IO	1/2 Watt Composition	1
78	24 K	± IO	1/2 Watt Composition	1
79	15 K	± IO	1/2 Watt Composition	1
80	6.8 K	± IO	1/2 Watt Composition	1
81	120 K		2 Watts Potentiometer	1
82	120 K	± IO	1/2 Watt Composition	1
83	220 K		2 Watts Potentiometer	1
85	68 K		2 Watts Potentiometer	1
86	330 K		I Watt Potentiometer	1
87	680 K		I Watt Potentiometer	1

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Schem. Symbol	Value	Tolerance per cent	Description	Quant.
88	60 K	± IO	1/2 Watt Composition	1
89	39 K	± IO	1/2 Watt Composition	1
90	18 K	± IO	1/2 Watt Composition	1
91	5.1 K	± IO	1/2 Watt Composition	1
92	25 K		2 Watts Potentiometer	1
93	47 K	± IO	2 Watts Composition	1
94	24 K	± IO	2 Watts Composition	1
95	24 K	± IO	2 Watts Composition	1
96	180 K	± IO	1/2 Watt Composition	1
97	100 K		2 Watts Potentiometer	1
98	180 K	± IO	1/2 Watt Composition	1
I00	202.5 ohms	± 0.5		1
I0I	132 ohms	± 0.5		1
I02	5000 ohms	± 0.5		1
I06	200 K	± IO	1/2 Watt Composition	1
I07	I K	± IO	1/2 Watt Composition	1
I08	I K	± IO	1/2 Watt Composition	1
I09	180 K	± IO	1/2 Watt Composition	1
IIO	IO K	± IO	1/2 Watt Composition	1
II5	2 meg	± IO	1/2 Watt Composition	1
II7	750 K	± IO	1/2 Watt Composition	1
II9	160 K	± IO	1/2 Watt Composition	1
I2I	I00 K		2 Watts Potentiometer	1
I22	75 K	± IO	1/2 Watt Composition	1
I23	43 K	± IO	I Watt Composition	1
I24	5IO ohms	± IO	1/2 Watt Composition	1

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Schem. Symbol	Value	Tolerance per cent	Description	Quant.
125	1,9 K	± IO	1/2 Watt Composition	1
127	47 K	± IO	2 Watts Composition	1
128	2.2 K		2 Watts Potentiometer	1
129	24 K	± IO	2 Watts Potentiometer	1
131	I00 K	± IO	1/2 Watt Composition	1
132	220 K		2 Watts Potentiometer	1
133	220 K	± IO	1/2 Watt Composition	1
136	3.9 K	± IO	2 Watts Composition	1
137	51 K	± IO	1/2 Watt Composition	1
139	I K	± IO	1/2 Watt Composition	1
141	I meg	± IO	1/2 Watt Composition	1
143	30 K	± IO	2 Watts Composition	1
147	IOO ohms	± IO	1/2 Watt Composition	1
152	5.1 K	± IO	1/2 Watt Composition	1
152	I00 ohms	± IO	1/2 Watt Composition	1
154	IO K	± IO	1/2 Watt Composition	1
158	120 K	± IO	1/2 Watt Composition	1
159	I K	± 0,5		1
160	425 ohms	± 0,5		1
161	148 ohms	± 0,5		1
162	I00 K		2 Watts Potentiometer	1
163	70 ohms	± 0,5		1
164	247 ohms	± 0,5		1
165	495 ohms	± 0,5		1
166	I00 K		2 Watts Potentiometer	1
167	148 ohms	± 0,5		1
168	425 ohms	± 0,5		1
169	I000 ohms	± 0,5		1

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Schem. Symbol	Value	Tolerance per cent	Description	Quant.
170	100 K		2 Watts Potentiometer	1
171	2 meg	± 10	1/2 Watt Composition	1
172	100 K	± 10	1/2 Watt Composition	1
173	10 K	± 10	1/2 Watt Composition	1
174	22 K		2 Watt Potentiometer	1
175	27 ohms	± 10	0.12 Watt Composition	1
176	100 K	± 10	1/2 Watt Composition	1
177	30 K	± 10	1 Watt Composition	1
179	1 K	± 0.5		1
184	10 ohms	± 0.5		1
189	1.8 meg	± 10	1/2 Watt Composition	1
190	100 K	± 10	1/2 Watt Composition	1
191	100 K	± 10	1/2 Watt Composition	1
192	200 K	± 10	1/2 Watt Composition	1
193	1 K	± 10	1/2 Watt Composition	1
194	1 K	± 10	1/2 Watt Composition	1
195	1 meg	± 10	1/2 Watt Composition	1
197	100 K	± 10	1/2 Watt Composition	1
199	100 K	± 10	1/2 Watt Composition	1
201	200 K	± 10	1/2 Watt Composition	1
202	510 K	± 10	1/2 Watt Composition	1
203	120 K	± 5	1/2 Watt Composition	1
206	8.2 K	± 10	1/2 Watt Composition	1
207	10 K		2 Watts Potentiometer	1
209	12 K	± 5	1/2 Watt Composition	1
210	100 K	± 10	1/2 Watt Composition	1
211	2 meg	± 10	1/2 Watt Composition	1
213	2 meg	± 10	1/2 Watt Composition	1

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Schem. Symbol	Value	Tolerance per cent.	Description	Quant.
214	82 K	± IO	1/2 Watt Composition	1
215	2 meg	± IO	1/2 Watt Composition	1
217	5IO K	± IO	1/2 Watt Composition	1
219	120 K	± 5	1/2 Watt Composition	1
221	8.2 K	± IO	1/2 Watt Composition	1
222	IO K		2 Watts Potentiometer	1
224	12 K	± 5	1/2 Watt Composition	1
225	IOO K	± IO	1/2 Watt Composition	1
226	2 meg	± IO	1/2 Watt Composition	1
227	2 meg	± IO	1/2 Watt Composition	1
228	51 K	± IO	1/2 Watt Composition	1
230	IO K	± IO	1/2 Watt Composition	1
231	5IO K	± IO	1/2 Watt Composition	1
233	200 ohms	± IO	1/2 Watt Composition	1
236	27 K	± IO	2 Watts Composition	1
237	75 K	± IO	1/2 Watt Composition	1
238	4.3 K	± IO	1/2 Watt Composition	1
239	IOO K	± IO	1/2 Watt Composition	1
241	200 ohms	± IO	1/2 Watt Composition	1
243	75 K	± IO	1/2 Watt Composition	1
244	2.7 K	± IO	1 Watt Composition	1
247	IOO K	± IO	1/2 Watt Composition	1
249	200 ohms	± IO	1/2 Watt Composition	1
252	27 K	± IO	2 Watts Composition	1
253	75 K	± IO	1/2 Watt Composition	1
254	2.7 K	± IO	1 Watt Composition	1
255	4.3 K	± IO	1/2 Watt Composition	1

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Circuit Symbol	Value	Tolerance per cent	Description	Quant.
R [illegible]	100 K	± 10	1/2 Watt Composition	1
R [illegible]	200 ohms	± 10	1/2 Watt Composition	1
R [illegible]	75 K	± 10	1/2 Watt Composition	1
R [illegible]	5.1 K	± 10	1/2 Watt Composition	1
R [illegible]	100 K	± 10	1/2 Watt Composition	1
R [illegible]	1 Meg	± 10	1/2 Watt Composition	1
R [illegible]	30 K	± 10	1/2 Watt Composition	1
R [illegible]	6.8 K	± 10	Wire Wound Potentiometer	1

Tubes and Crystal Diodes

Circuit Symbol	Description	Quant.
1	Type 5U4G tube	1
2	Type 6U4H tube	1
3	Type 6CI9H tube	1
4	Type 6CI9H tube	1
5	Type 6K3H tube	1
6	Type 6T2H tube	1
7	Type 6K3H tube	1
8	Type 6HIH tube	1
9	Type 6H2H tube	1
10	Type 6HIH tube	1
11	Type 6HIH tube	1
12	Type 6H2H tube	1
13	Type 6H2H tube	1
14	Type 6H2H tube	1
15	Type 6H2H tube	1

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Schem. Symbol	Description	Quant.
16	Type 6ЖIП tube	1
17	Type 6ЖIП tube	1
18	Type 6ЖIП tube	1
19	Type 6ЖIП tube	
46	Germanium diode, type Д7Г	1
47	Germanium diode, type Д7Г	1
48	Germanium diode, type Д7Г	1
49	Germanium diode, type Д7Г	1
50	Germanium diode, type Д7Г	1
51	Germanium diode, type Д7Г	1
52	Germanium diode, type Д7Г	1
53	Germanium diode, type Д7Г	1
I03	Germanium diode, type Д2В	1
I04	Germanium diode, type Д2В	1
262	Germanium diode, type Д2В	1

Miscellaneous Components

Schem. Symbol	Description	Quant.
I0	Signal lamp, type МН-14, 6.3V, 0.28 A	1
21	Choke	1
42	Choke	1
54	3A Fuse	1
55	Mains cord	1
56	Power Transformer	1
57	Socket, type ПЛ-2П	1
58	Socket, type ПЛ-2П	1

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Schem. Symbol	Description	Quant.
59	Toggle Switch, type TB2-1	1
99	Microammeter, type M-24, 0-50 uA	1
112	Choke	1
144	Plug	1
145	Inductance coil, 465 kc/s	1
156	Connector	1
157	Socket	1
180	Plug	1
187	Choke	1
188	Plug	1
265	Microammeter, type M-24, 0-100 uA	1
91	Relay type PCM-2	1
92	Relay type PCM-2	1
93	Relay type PCM-2	1
94	Relay type PCM-2	1
95	Relay type PCM-2	1
96	Relay type PCM-2	1
97	Relay type PCM-2	1
98	Relay type PCM-2	1
99	Relay type PCM-2	1
910	Relay type PCM-2	1
911	Relay type PCM-2	1
912	Relay type PCM-2	1
913	Relay type PCM-2	1
K1	Key type KTPO-IH-22-22/7-7	1
K2	Key type KTPO-IH-7-7/7-7	1

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Schem. Symbol	Description	Quant.
K3	Key, type KTPO-IH-22-22/7-7	1
K4	Key, type KTPO-IH-7-7/7-7	1
K5	Key, type KTPO-IH-7-7/7-7	1
K6	Key, type KTPO-IH-7-7/7-7	1
K7	Key, type KTPO-IH-7-7/7-7	1
K8	Key, type KTPO-VH 3-IO	1
K9	Key, type KTPO VH 3-IO	1
K10	Key, type KTPO VH 3-IO	1
K11	Key, type KTPO VH 3-IO	1
K12	Key, type KTPO VH 3-IO	1
K13	Key, type KTPO IH 7-7/7-7	1
K14	Key, type KTPO VH-7-7	1

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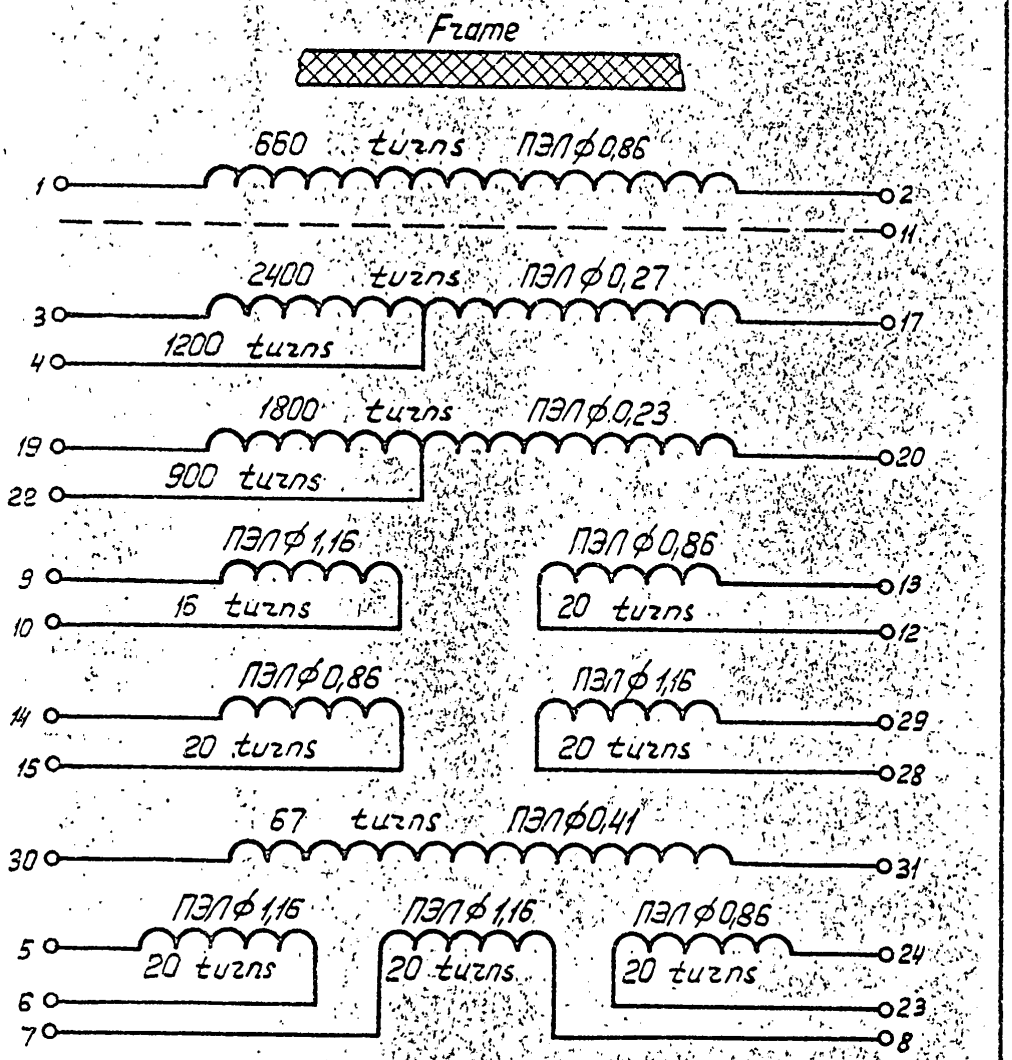
П2-2 Transformer winding



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П2-2 Choke winding

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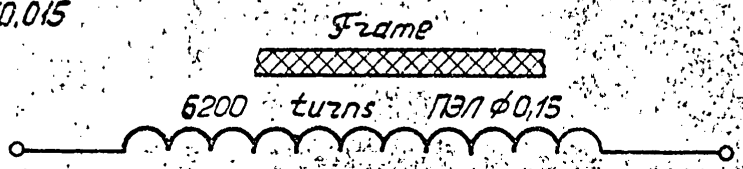

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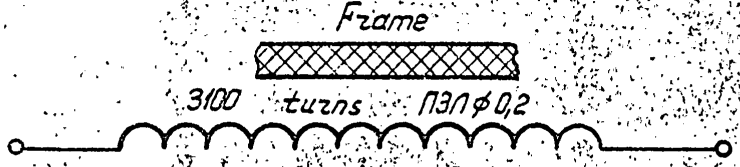

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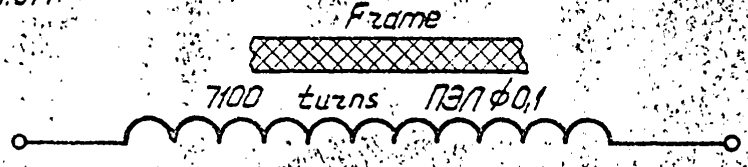

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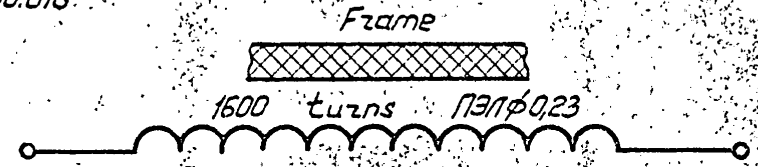

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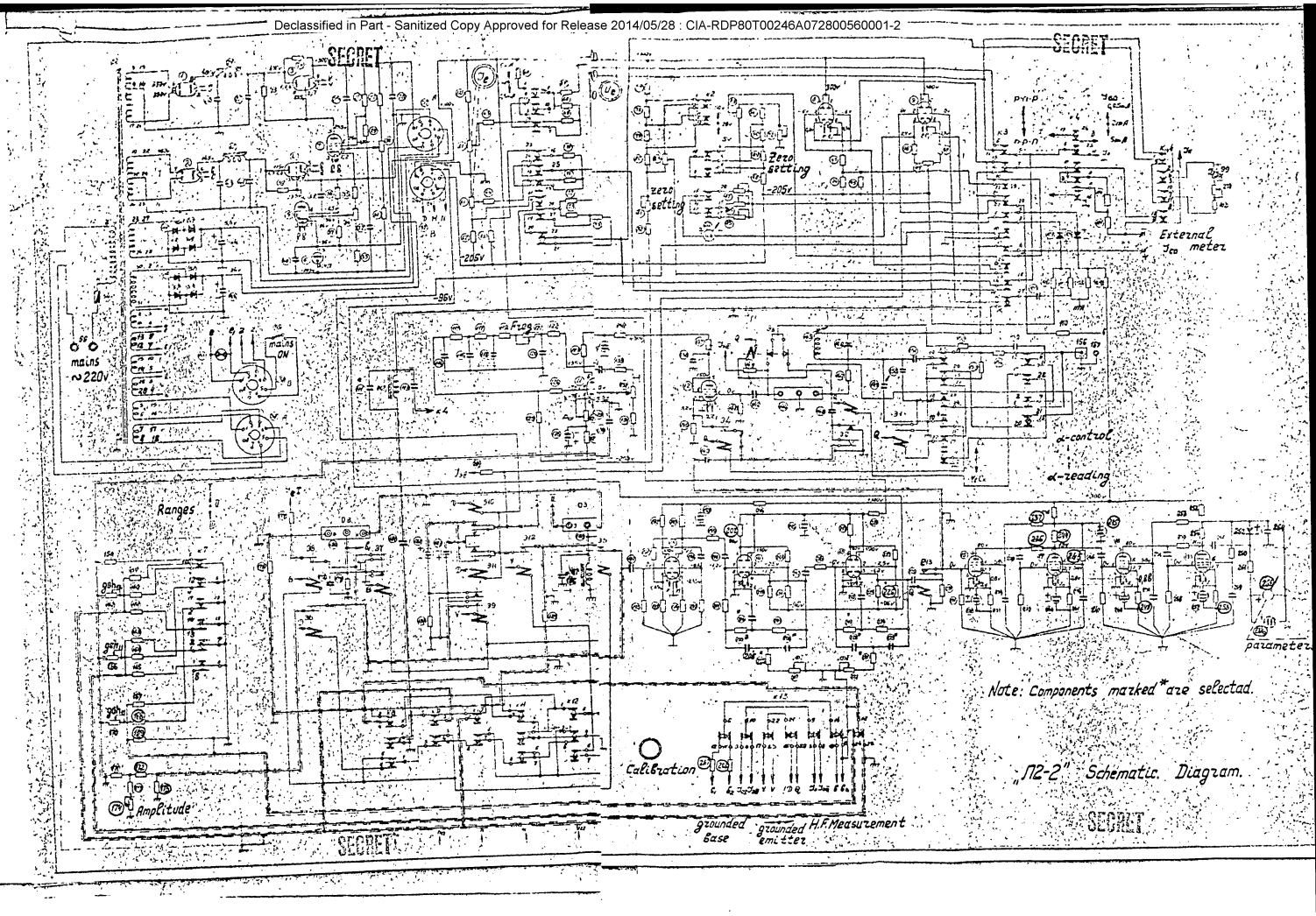

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